# FERTILIZERS

—FROM THE—

# MANUFACTURER'S STANDPOINT.

## A PAPER

PREPARED FOR THE VERMONT DAIRYMEN'S ASSOCIATION, AND READ BEFORE THAT BODY, JANUARY 16, 1889; ALSO DELIVERED BEFORE THE RHODE ISLAND BOARD OF AGRICULTURE AND STATE SOCIETY, FEBRUARY 20, 1889.

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MONTPELIER:
PRESS OF THE WATCHMAN PUBLISHING COMPANY.
1889.

# Fertilizers from the Manufacturer's Standpoint.

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When Adam entered the Garden of Eden, six thousand years ago, more or less, he found a fertile soil, a profusion of fruits and flowers, and luxuries of nature. We are told that if he had been content with these luxuries God would not have put upon him the curse of earning his bread by the sweat of his brow.

Now I am one of those who believe it was foreordained that man should earn his bread by the sweat of his brow. God planted in him curiosity, and a thirst for knowledge; hence, the first thing Adam did when he entered the Garden, was to taste of the forbidden fruit. He was seeking knowledge.

God also knew that as man sought knowledge, his wants would increase; that he would in time consume the bounties of nature, and finally tax the fertility of the soil.

God also probably foresaw that as man was obliged to earn his bread by the sweat of his brow, there would develop in him a sense of greed, and that he would seek to profit, so far as he could, by his labors, forgetting the future and his obligations to posterity.

Man was created a social being, fond of society, and as society grew, men congregated together in large centres, and as they increased and multiplied, a greater tax was placed upon nature.

The Creator foresaw that cities would grow up which would draw on the fertile country for their support and to sustain the life of these cities and secure the public health, they would consequently have to be supplied with channels of traffic and drainage, thus transferring the fertility of the fields to the city, and finally to the sea.

## NATURAL DEPOSITS.

We are taught that nothing in nature is wasted, but is simply lost to the uses of man, or a generation of men. It may be recovered at another age of the world, or by another generation. An all-wise Providence foresaw this, for, in order to make good this loss, He has caused great deposits of crude materials to be placed in all parts of the world.

He has caused inland seas to dry up, and deposit, in that part of the world which we now call Germany, their contents of potash and common salt. He buried great forests in Russia and in the United States, from which to-day we are drawing oil and

coal, and chemical salts which enter into plant food. He drove myriads of animals out of the sea on to the land in Spain, and in America, and, in this century, when we need them, we find them deposited as phosphate of lime, coprolites and soft guanoes. He made great pockets in Canada, into which he poured millions of tons of apatite, the mother source of phosphoric acid, and the predominant element of bone, and without which no skeleton of any living animal could be organized. He planted sulphur in Sicily, from which man by the aid of chemistry, manufactures sulphuric acid with which to dissolve this phosphate or apatite, and so make it quickly available for plants.

He placed in different parts of the United States, in Massachusetts, Vermont an just over the line in Canada, great deposits of copper pyrites, or "fool's gold," from which this sulphur can also be obtained.

He caused great deposits of organic matter to be placed under the equator in Chili, which by heat and moisture has been converted into a chemical salt which we are now mining as nitrate of soda, and from which we draw large supplies of nitrogen, the most costly part of all plant food.

And so I might go on enumerating the different natural deposits of crude materials which directly interest the farmer as a source of plant food, and a means of recuperating the soil which has been taxed by generations, and by injudicious culture. Perhaps these materials which an all-wise Creator has placed in different parts of the world are simply the lost products, or the waste of a cycle of civilization which existed upon this earth beforo Adam entered the Garden of Eden, and by the shifting processes of nature,—the upheaval of land and sea, the drying up of waters, has again been brought into use, and so rounding out a grand scheme of evolution and compensation.

Thus we see that these crude products, specimens of some of which I have before me, are placed for man's use ; and those which directly go to fertilize the soil are the ones with which I shall deal to-day.

## WHAT CHEMISTRY HAS TAUGHT US.

The chemist has taught us that plants are composed of certain ingredients known as organic and inorganic or mineral ; that plants average to take from eighty to ninety per cent of their weight from the air, while the other ten or twenty per cent is taken from the soil, and that if man draws from the deposits which have been placed for his use, this small quantity of mineral matter, he can make his worn-out soil as rich and fertile as of old, and to blossom like the Garden of Eden.

New soil usually contains enough plant food for a number of crops. In some places crops have been raised for generation

after generation without seeming to exhaust its fertility, and in other localities the virgin fertility has been exhausted in one or two crops.

Man has determined not only what these ingredients are which it is necessary for him to supply, but he has determined the various forms which are most suitable to plant growth. He has found that most soils yet contain all that is required of the ordinary plant ingredients, such as lime, silica or sand, iron, magnesia and many others, but that nearly all soils have been exhausted of their potash, their phosphoric acid or phosphate of lime, and their nitrogen. That if we supply these ingredients, every agricultural soil may be made fertile again.

Why these have been exhausted more than others, is because the crops which we grow contain more of these than they do of the minor ingredients.

According to the Stockbridge formulas, 100 bushels of potatoes take from the soil 21 pounds of nitrogen, 34 pounds of potash, and 11 pounds of soluble phosphoric acid; 50 bushels of Indian corn take 64 pounds of nitrogen, 77 of actual potash, and 30 pounds of soluble phosphoric acid; one ton of English hay requires 36 pounds of nitrogen, 31 pounds of potash and 12 pounds of soluble phosphoric acid; and so I might go through the list, showing that these are the leading constituents, while the others, although important, are taken from the soil in smaller quantity, and of which most soils have an abundant supply for years to come.

## SOURCES OF PLANT FOOD.

To furnish the necessary ingredients which I have mentioned, we in this country draw upon Germany for the potash, upon South Carolina and Canada for phosphoric acid, upon Sicily, Vermont and Spain for sulphur, and upon Chili for nitrogen, and also upon the waste products of all the mauufacturing industries throughout the world.

Stable manure is one of the waste products of the agricultural industry; perhaps it is better termed a by-product. It contains all the fertility that has been taken out of the soil, less what man has absorbed for his support or the support of the animals which he keeps. If we plowed in all the crops we raise, it will be readily seen we should not exhaust the soil at all, but when we sell off potatoes, vegetables, grain and milk, we are taxing it in a greater or less degree, and are taking from it as many pounds of plant food in proportion as we take off pounds in agricultural products. To supply these drafts of man, nature has responded in a liberal manner, but now she says: "I can give you out of my great storehouse of fertility, an abundance of some of the minor ingredients, but if you wish to draw upon me further, you must make deposits in my store-

house of such ingredients as I do not possess, and in such forms as will be available for your uses. If you will do this, I will still continue to honor your drafts in the future as in the past."

How then to assist nature in carrying on her part of the work is the problem of the farmer to-day, and the manufacturer of fertilizers with his capital, his experience and his knowledge of chemistry comes to his assistance.

My friend, Professor Whitcher, of the New Hampshire Agricultural College, who is doing a noble work for the cause of agriculture, will tell you that the farmer has little or no use for the fertilizer manufacturer, as he can manufacture his fertilizers at home, and thereby save money, which I grant is a most important consideration. I agree with him up to a certain point. The manufacture of fertilizers, however, does not mean simply mixing these crude products together. That is only one stage of the process.

THE MANUFACTURE OF FERTILIZERS

begins back of this. It begins with the crude and by-products which require manipulation and treatment before they are even ready for home mixing.

Take bone for example. The manufacturer begins by gathering it from the slaughter-houses throughout the land; he extracts from it the grease which is of no value as a fertilizer, steams it in digesters under 60 pounds pressure, grinds it in mills requiring from 15 to 20 horse power, in order to make it fine, so that it may be evenly mixed in a fertilizer, or evenly distributed over a field. In short, he makes it available for plants. No farmer can do this unless he has these appliances. He may burn it at home and pound it up, but in that case he loses the most valuable part of the bone, namely, the ammonia, which goes into the air, and is lost to his uses.

Besides bone, almost every drop of blood and piece of waste meat is now saved throughout the land. This used to be fed to the hogs, and made pork that it is no wonder the Jews rejected. It is now gathered together by the manufacturer of fertilizers, and by means of steam and large dryers, is brought to a fine dry powder, freed of its moisture and grease, and containing twelve to eighteen per cent of nitrogen, a most valuable source, which used to be practically wasted.

The South Carolina phosphate and Canadian apatite which supplement bone, is mined from the depths of rivers, seventy, eighty and a hundred feet below the surface. Apatite is quarried in the deposits of Canada. The phosphate rock must be washed and dried, and the apatite must be freed from foreign material, and then both must be ground in mills adapted to the purpose.

The sulphur which is mingled with the copper and iron in

the mines, must be eliminated in furnaces, and the gases gathered in large leaden chambers, and by a complicated process involving elaborate chemical apparatus, and requiring skill, is converted into a liquid which, next to water, is the greatest solvent in agricultural chemistry. The manufactuer of fertilizers is not content with this, but he sends out his vessels and steamers into the bays and sounds along the Atlantic coast, and gathers in great schools of menhaden fish, which are thought to feed to some extent upon the drainage which is poured out of the great cities, thus immediately recovering some of the lost fertility. These fish are steamed, placed in large presses, the oil extracted, and the pomace, looking very much like apple pomace, is dried, and becomes a valuable source of nitrogen and phosphoric acid.

## WASTE PRODUCTS.

The manufacturer roams the world over, gathering plant food wherever he can find it. If a cargo of damaged tea comes into New York, he buys it, because it contains plant food, thus transferring fertility from Asia to America.

The wine maker skims from his casks a deposit which is sold as argols. These argols are taken by the manufacturer of cream of tartar, and the bi-tartrate of potash extracted, which is again sold to the manufacturer of baking powders, but in this process there is left a waste product known as tartar pomace, which also contains plant food, and is purchased by the manufacturer of fertilizers; but it comes to him in a condition that requires drying and chemical manipulation before it can be used.

The sugar refiner has found that charcoal made from bone is the best material through which to strain his syrups and clarify and make white his sugars; but after a time it becomes loaded with impurities, and worthless for his use. It then finds its way to the fertilizer manufacturer, who knows it to be a valuable source of phosphoric acid, but it comes to him in large grains, often wet, and must be dried and ground and finally dissolved in sulphuric acid to be made available for plants.

The gas manufacturer puts in his retorts the soft coal which is converted into gas; but there runs along with it a large deposit of liquor which the manufacturer gathers, and from which he makes a pure white salt, known as sulphate of ammonia, which is also another valuable source of nitrogen, and is also used for making aqua ammonia, alum and smelling salts.

The steel maker who is manipulating his iron ore under the new process, throws into his great retorts of molten iron quicklime, which immediately combines with the phosphorous in the iron, and forms a slag, which contains fifteen to twenty per cent of phosphoric acid, and is another product that comes to the manufacturer of fertilizers in large lumps and nodules, re-

quiring to be ground and treated in order to be made available.

### LEATHER WASTE.

Even the shoemaker produces a waste known as "chippings," which finds its way into the hands of some manufacturers. Let the shoemaker be ever so careful in cutting up his leather, there will be small bits which cannot be utilized, although I am told they now nse them by means of glue, in making pieced heels, and also in the production of leather-board; but these leather scrapings and cuttings, after the oil is extracted by the aid of steam and presses, are sold as a source of ammonia.

I am glad that your new fertilizer law in Vermont makes the use of this source of ammonia unlawful, and if it could only be detected in fertilizers by chemists, its use would be absolutely prevented. There is eight or ten per cent of ammonia in leather waste, but it is considered insoluble and unavailable for plants, and, therefore, an inferior source of plant food. Dr. Voelcker, chemist to the Royal Agricultural Society of England, says he would rather have one per cent of ammonia in the form of sulphate of ammonia than six per cent in the form of powdered leather. I do not think any reputable manufacturer selling fertilizers in the State of Vermont uses it to any extent; but Professor Cooke, your inspector, should be on his guard, and look for it with an eagle eye.

The wool manufacturer clips from his woolens a waste which also contains nitrogen; and the manufacturer of buttons and combs from horns and hoofs produces a waste which is another source of nitrogen, all of which are more or less valuable, and all of which require treatment to make them available.

### INTELLIGENT MANUFACTURE.

Thus I might go on naming industry after industry producing by-products which directly concern the manufacturer of fertilizers. I can hardly name any staple industry that does not touch the fertilizer industry at some point. Hence, as you will see, the intelligent manufacture of fertilizers is not shoveling a little of this or that together, without rule or reason, and calling it a compound fit for the kings of plant life. It is a more comprehensive and complicated business than this would imply.

The good housewife makes bread at home, but how much thought and skill has gone into the preparation of the flour and yeast, and even the stove in which the bread is baked. The process of making phosphate can be stopped half-way, and the ground phosphate, dissolved bone, chemicals or dried blood can be shipped to the farmer, and he can mix them at home, but this is not the manufacture of fertilizers. When it is done on

a large scale, at the rate of one hundred or two hundred tons a day, it requires large buildings suitably arranged with elevators, bins, mills, mixers and scales that will record the weight of a carload at a time, and others in the laboratory so delicate that they will turn at the weight of a hair. The final mixing is but the last and easiest stage in a long series which require an extensive and expensive plant, and the employment of skill and large capital for its economical accomplishment.

No one would think of sweeping these things together which I have before me, and calling the result a mixed fertilizer, for the product would be no more a fertilizer than milk from the cow can be called butter, or raw meat digestible food.

It is safe to say that the crude materials as they are received require to be handled at least six or seven times before the finished product is placed upon the cars for shipment, and you must remember that a ton of fertilizer or fertilizing material is just as heavy to handle in a fertilizer factory as on the farm.

Thus far in this paper, I have tried to show the essential ingredients of plant food, their sources, and the processes of manufacture. The practical question with every farmer here to-day is

## HOW TO OBTAIN THIS PLANT FOOD IN THE CHEAPEST AND BEST FORMS.

In the first place, the farmer must remember that in buying chemicals he is taking as much risk as to the strength and quality of these as he is in the mixed fertilizer, for it is just as easy to adulterate the one as the other. You have in Vermont recently passed a most excellent law, which requires that manufacturers shall not only "state what they sell," but shall "sell what they state." That is to say, they shall guarantee the per cent of ammonia, potash and phosphoric acid in the materials, as well as in the mixed goods, and if that law is worth anything and is enforced, as no doubt it will be under Professor Cooke, (as the old law has been for the past three years), the farmer is just as much protected in purchasing mixed materials as he is in those which are half prepared. So, when men say that if you buy the unmixed chemicals you will be more likely to get what you buy, they say that which is untrue.

## HOME MIXING.

No doubt you can figure out a saving between the prepared chemicals and the mixed fertilizer. Your wife can take the milk left over from day to day, set it, raise cream and make butter from it, and from the skim-milk a soft curd cheese, but it would not be such butter nor such cheese as is made in the factories of the country. As a source of food it would have a value, but whether it would be as digestible and palatable as that ob-

tained in the market, is quite another question. Whether you can mix the half-prepared chemicals so that they will be as evenly combined and as carefully distributed over your field, is a question for you to consider. You doubtless know that the amount of actual plant food which you apply to an acre is very small, indeed, as compared with the great bulk of soil. Professor Battles, of the North Carolina Experiment Station, says: "If the application of three hundred or four hundred pounds of fertilizer is thoroughly mixed with the soil, and an average sample obtained, by no chemical means can this amount be detected, and yet this application changes the yield from an unproductive to a productive one, and measures the line between success and failure." He further says, "NOT ONLY DOES THIS THREE HUNDRED POUNDS TO THE ACRE ESCAPE DETECTION BY CHEMICAL MEANS, BUT IT IS ALSO THE CASE WITH FIVE HUNDRED POUNDS, ONE THOUSAND POUNDS, AND EVEN WITH A TON APPLIED TO THE ACRE." Now if this is the case, how important it is that the fertilizer which we apply shall be in the best form, thoroughly mixed and carefully applied, so that it may be easily and quickly absorbed by the growing plant.

### THE CASH SYSTEM AND AGENCIES.

It must also be borne in mind that if the chemicals and prepared materials are bought unmixed, cash must be paid for them, and I wish the cash system of buying fertilizers could be adopted throughout the country. We were gathering together materials last June, July and August and all through the summer and fall which we are now manufacturing into fertilizers, and which will be shipped into Vermont and other States this spring. We shall not get our pay for this fertilizer until next fall, or from twelve to eighteen months after the first material is put into the factory. This is all wrong, but it is the custom of the trade. Interest accrues, and interest is as much a part of the cost as the material, and must be added into the cost of the fertilizer. Then, too, there is an element of risk as well as a large shrinkage, which are items to be counted in. On the other hand, chemicals are sold free on board cars, and the purchaser pays the freight. In the case of mixed goods, the manufacturer delivers them to almost every station throughout the Eastern States, which averages to add three dollars more to the cost. He is also obliged to pay commissions to agents. If he attempted to supply the trade, shipping to each individual farmer, the business could not be done, because farmers, as a class, will not order until the last moment, and to ship out the whole year's product of a fertilizer factory in thirty to sixty days in spring would be impossible; hence, the manufacturer is obliged to ship ahead, and place in store-houses and in the

hands of agents for distribution. Perhaps the time will come when all this will be changed, and the consumer and the producer brought directly together. As for one, I shall welcome any change which will bring the business nearer a cash basis.

### PROFITS OF THE BUSINESS.

It makes little difference to us whether we sell the mixed goods or the prepared chemicals. We are in the business for a living and a legitimate profit, the same as you are in the business of farming for a living and legitimate profit, and it is immaterial whether it comes to us on unmixed chemicals or on prepared fertilizers. The profit is not large in either case; some of you perhaps imagine it is ten, fifteen or twenty dollars a ton; but let me assure you that it will not average over $2.00 a ton on the mixed fertilizers sold in New England for the past year. I have made the statement, and am willing to repeat it now, that if any one will guarantee the concern with which I am connected, a net profit of $2.00 per ton on the output of our factory for the next ten years, he may have any surplus which accrues above this amount.

### PURCHASE OF PLANT FOOD.

In purchasing fertilizers, you want to consider that you are purchasing plant food. Don't let a ton of fertilizer mean simply a ton. Some tons of fertilizers contain two hundred pounds of plant food, and others five hundred pounds, but those tons that contain five hundred pounds can not be bought for the same price as those that contain only two hundred. We manufacture fertilizers running in all strengths; from one to eight per cent of ammonia, and from one to ten per cent of potash, and from five to twenty per cent of phosphoric acid, and each has its respective value. When we buy fertilizer materials in the open market, we buy it on the content of plant food. You should buy mixed fertilizers or chemicals in the same way, and should consult your State Chemist, Professor Cooke, and the admirable tables which he publishes, to know what the different things contain, or the different brands of fertilizer analyze, and also the different forms in which the plant food exists.

It is with this as it is with milk; some samples of milk carry ten and others fifteen per cent of solids; the Massachusetts law requires thirteen per cent. Some samples of butter carry ten per cent of water, and others twenty per cent, and, other things being equal, that butter which contains only ten per cent of water is worth more as an article of food than that

which carries twenty per cent, and why should not butter and cheese be sold upon their content of food constituents as any other article of commerce?

## FORMS OF PLANT FOOD.

Many have urged farmers to use phosphates in their raw state, particularly the crude South Carolina phosphate, contending that plants will absorb the phosphoric acid and make it available, and that by using it in this form they will get more for their money. I grant this is true to a certain extent. But is crude South Carolina phosphate as available as the dissolved? The crops which you are growing here average to mature in sixty to ninety days. The seasons here are short. The plants must have their food every hour they are in the soil, and it must be available or they will not grow. If you think you can trust quick-growing crops on insoluble fertilizers, that is for you to determine, but in my judgment, taking the seasons as they go, wet and dry, hot and cold, you will find you will be the loser. You have to take a great risk as to the weather. That is the largest factor in raising crops. Can you afford to take any risk in the seed, the kind of fertilizer used, or the culture employed, factors over which you have control?

## VALUE OF STABLE MANURE.

Stable manure is the best source of plant food, all things considered. We can not manufacture anything equal to it. It supplies plant food gradually throughout the season, and seems to be adapted to the various kinds of plants. It should, however, be applied in its crude state, because you cannot afford to compost it. It is also particularly adapted to grassland, and should be used in more liberal quantity upon grass fields near at hand. A ton of stable manure, according to Dr. Goessmann, contains only about twenty-five pounds of actual plant food, the other one thousand, nine hundred and seventy-five pounds being water, straw and organic matter. You can not afford to haul this one thousand, nine hundred and seventy-five pounds a long distance. Your rule should be to apply stable manure in larger quantities upon grass fields easy of access, and after that gives out, purchase, if you have faith, some form of plant food in the shape of chemicals or mixed fertilizer, adapted to hoed crops. It is generally conceded that better potatoes can be raised upon fertilizer than upon stable manure, and that the sulphate of potash is better for fruits than the muriate, and that nitrate of soda is a specific for grass. These are questions which relate to the form of plant food, and which has as much influence upon the quality and amount of the crop as the quantity applied.

FARMERS AND MANUFACTURER ALIKE INTERESTED.

This talk may appear to many of you to be in the interest of fertilizer manufacturers, but is it not also in your interest? Is it not for your interest to have all these crude materials gathered from all parts of the world, brought to your door available for plants? Has not your own Professor Cooke shown in his last bulletin, just issned, that by competition and careful inspection, there has been a total gain of twenty-one per cent in favor of the purchaser in the last three years, or a saving in the State of Vermont alone, of $21,000 on the single item of fertilizers?

Again, can you afford to starve your crops any more than you can afford to starve the cows in your barn? Before this meeting is over, there will be a great deal of discussion touching the feeding of dairy stock. Should you not also discuss how to feed the plant which feeds the cow, and is not the feeding of the plant at the basis of all other feeding? Given cheap plant food, would not the farms of Vermont flourish as of old?

I beg of you not to understand that I am talking to-day of the fertilizers of old. The fertilizer business has progressed with every other business, and I am considering plant food the same as you will discuss animal food.

Let me suggest that you go to Professor Cooke, or any other competent authority, and ask him how you shall feed your plants, and where you shall obtain the food with which to feed them, and finally, let me impress upon you to

FEED THE PLANT RATHER THAN THE SOIL.

We have heard a great deal about feeding the land, and it has crystallized into the maxim: "Feed the land, and the land will feed you."

At first thought, this strikes one as exceedingly sensible and practicable, but experience has shown that this is wrong, both in theory and practice. The soil—what is it? So far as plant food is concerned, it is an enigma, but practically, it is a store house of plant food, and a medium through which plants are fed. To be sure, it is more than a medium or receptacle, for it not only receives plant food, but helps to prepare it for assimilation. *But the soil has no life in itself, hence no wants.* You can not feed a dead body. It is the living, breathing plant which grows and thrives on the food fed to it by nature or by man.